



1955 RUBLE-DOLLAR RATIOS FOR CONSTRUCTION  
IN THE USSR AND THE US



August 1964

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CIA/RR ER 64-26

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1955 RUBLE-DOLLAR RATIOS FOR CONSTRUCTION  
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Summary and Conclusions

A comparison of the costs of construction of 25 Soviet construction projects, in 1955 rubles,\* with 25 comparable construction projects in the US, in 1955 dollars,\*\* shows the following 1955 ruble-dollar ratios by sector of construction weighted by the mix of construction in the US (in rubles per dollar):

Industrial	0.71
Housing	0.66
Highway	1.00
Transportation and communications (except highway)	0.73
Commercial and all other	0.68

Weighted by the mix of construction in the USSR, the over-all ruble-dollar ratio for construction is estimated at 0.70 ruble per dollar; weighted by the mix of construction in the US, this ratio is estimated at 0.71 ruble per dollar. The geometric mean of the Soviet-weighted ratio and the US-weighted ratio is 0.70 ruble per dollar, which is within plus or minus 1 percent of each of the weighted ratios. The simple geometric mean of the unweighted ruble-dollar ratios for the 25 pairs of Soviet and US projects also is 0.70 ruble per dollar, the simple arithmetic mean is nearly the same at 0.71, and the median ratio is 0.72.

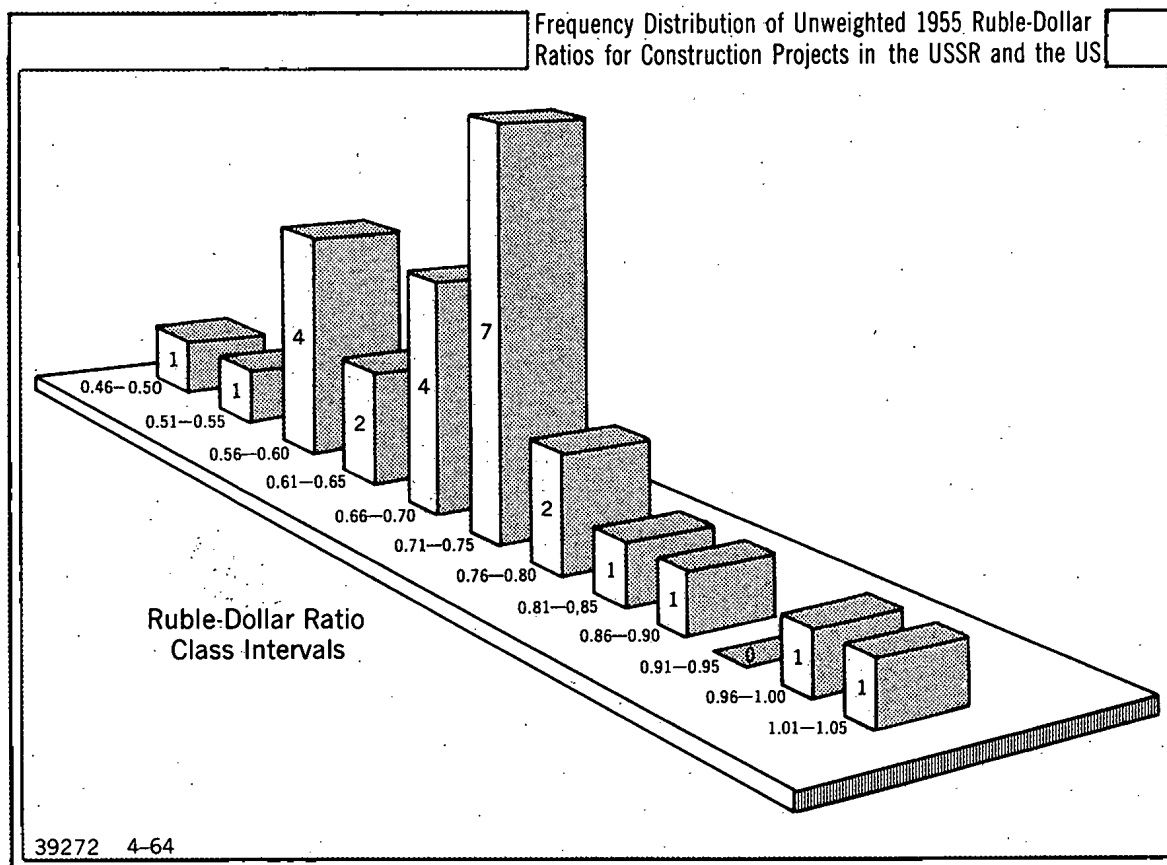
The unweighted ruble-dollar ratios for the 25 pairs of projects show a reasonably strong central tendency for so small a sample (see the accompanying chart\*\*\*). Ideally the sample of projects should be much larger, but its size and composition were limited chiefly by the data available on Soviet construction. As a result, the projects that are compared are more representative of construction in the USSR than in the US. All things considered, there do not appear to be any important factors that would make for an upward bias in the ratios obtained. There are, however, two major sources of downward bias in the ratios -- the impossibility of direct comparisons of the costs of complex industrial projects (chemical plants, oil refineries, and so on) and the impossibility of accurate adjustments for the lower quality of construction in the USSR. Some further downward bias is introduced by the use of Soviet estimate costs† for comparison with US bid prices.

\* Ruble values in this report are given in new rubles expressed in terms of 1955 prices.

\*\* Unless otherwise indicated, dollar values are given in 1955 US dollars throughout this report.

\*\*\* Following on p. 2.

† See II, C, p. 7, below.



The cost ratios for complex industrial projects in the USSR and the US almost certainly would average higher than the average cost ratios of such relatively simple structures as warehouses and industrial shops. The inclusion of complex industrial projects, therefore, would raise the ratio for industrial construction. Adjustment for the lower quality of construction in the USSR also would raise the ruble-dollar ratios, particularly in the housing sector. The downward bias in the ratios that were obtained for housing results not only from the lower quality of construction in the Soviet housing projects that are compared with US housing projects but also from the inadequate representation of the wide range of high-quality housing constructed in the US.

If it were possible to adjust the unweighted ruble-dollar ratios for the downward biases imparted by the lower quality of construction in the USSR and by the inadequate representation of construction in the US,\* the US-weighted ruble-dollar ratio would be increased. The Soviet-weighted ruble-dollar ratio would rise also, but less so than the US-weighted ratio because of the greater weight of housing construction in the US. Were such adjustments feasible, therefore, the spread between the Soviet-weighted ratio and the US-weighted ratio would be widened.

A recent Soviet study of ruble-dollar ratios in construction obtained an over-all ratio of 0.78 ruble per dollar, in 1955 rubles and

\* In both respects the ruble-dollar ratio for housing would seem to suffer a substantially stronger downward bias than the ratios for other types of construction.

1954 dollars, weighted by the mix of construction in the USSR in 1958. In industrial construction the average ruble-dollar ratio obtained by the Soviet study (adjusted to 1955 prices) was nearly identical to that obtained for projects of a similar category in this report. In deriving ruble-dollar ratios for housing construction, however, errors in methodology in the Soviet study resulted in the extremely high ratio of 0.90 ruble per dollar (1955/54 prices). In deriving the comparative unit cost of Soviet and US housing, the Soviet study failed to adjust for critical differences between methods of measuring floorspace in the USSR and the US. Moreover, the dollar cost derived for US housing was an implicit average of both individual houses and apartment housing, whereas only apartment housing was priced on the Soviet side. This procedure also yields an upward error in the ratio because the average construction cost of apartment housing is greater than that of individual housing in both the USSR and the US. Thus the difference between the over-all Soviet-weighted ratio for construction as derived by the Soviet study (0.78 in 1955 rubles and 1954 dollars) and the over-all ratio derived in this report (0.70 in 1955 rubles and dollars, using Soviet weights) is explicable chiefly as resulting from the way in which the Soviet study estimated the ratio for housing construction.

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## I. Introduction

Derivation of ruble-dollar ratios for construction is made much more difficult than for most other industries by the very nature of the construction end-product: the completed construction projects. Unlike the products of most other industries, construction projects usually are individually custom-built and, therefore, are heterogeneous even within given types of construction (for example, housing). Standardization of designs can lessen the problem of heterogeneity in construction, especially within a given country. Construction by standard designs, however, is only a very small share of total construction in the US, in comparison with the extensive use of standard designs in Soviet construction.

In deriving ruble-dollar ratios for construction, several distinct approaches can be taken, including (1) a projects comparison, (2) an inputs comparison, (3) a components comparison, and (4) a service comparison. Each of these approaches presents a number of methodological difficulties, but it is believed that a projects comparison is more practicable because of the greater availability of data for it than for the other approaches. The major part of this report, therefore, presents a consideration of the problems involved in using the projects approach and an exposition of the steps and data used in calculating ruble-dollar ratios for Soviet and US construction projects. The alternative approaches (inputs, components, and service comparisons) are discussed briefly,\* and ruble-dollar ratios for construction materials and for construction components are investigated on a limited scale. Finally, the results of a Soviet study of ruble-dollar ratios for construction are discussed.

## II. Methodology of the Projects Approach

One of the major purposes of a study of construction ruble-dollar ratios is to permit comparisons of the volume of construction in the USSR and the US. In providing a basis for such comparisons the projects approach has the advantage of pricing construction outputs rather than inputs and thus does not raise the troublesome problem of productivity adjustments that is inherent in the inputs and components approaches. Moreover, the projects approach can easily yield sectoral ruble-dollar ratios -- that is, separate ratios for industrial construction, housing construction, and so on (although data are not presently available for weighting the various types of projects within sectors).

In theory a study of ruble-dollar ratios in construction should compare the costs of construction\*\* (that is, selling prices) of Soviet and US construction projects that are as nearly alike as possible in the designs, specifications, and construction materials used. As already indicated, however, the custom-building nature of much of construction activity results in heterogeneous end products in construction in a given country, in contrast to the series production

\* See IV, p. 14, below.

\*\* For a discussion of the concept of cost of construction as used in this report, see II, C, p. 7, below.

characteristics of most industries. The problem of heterogeneity of the end products of construction within an economy obviously is complicated even further when the products of construction in two different economies are to be compared. The question thus arises whether or not it is possible to find construction projects that are internationally homogeneous between the USSR and the US in sufficient numbers to support the use of a projects approach in deriving ruble-dollar ratios.

Given the information available on Soviet and US construction, it is believed that if all projects of a given type of construction (for example, housing) were to be arrayed and classified by the designs, specifications, and construction materials used in the two countries, there would be many projects which, although not identical, would be similar enough to warrant direct comparison. On the other hand, the projects in each country for which a directly comparable counterpart project could not be found would be greater in number (including many that would have to be considered unique to one country or the other). The problem of noncomparability theoretically could be handled by estimating the costs of duplicating a selection of Soviet (US) projects in the US (USSR), weighted by the relative importance of the projects in Soviet (US) construction. However, the information required for such duplicative costing at an acceptable level of precision is not at present available. In this report, therefore, attention has been concentrated on deriving ruble-dollar ratios for what are judged to be comparable counterpart projects.

The major tests for the validity of such an approach are (1) the comparability of the projects paired between the USSR and the US, (2) the representativeness of the projects within each country, and (3) the size of the sample of projects. To the degree that given samples of projects meet the tests of comparability and/or representativeness less satisfactorily, it is evident in a relative sense that the sample of projects should be increased. In the absolute sense, however, the necessary size of the sample of projects is indeterminate. A strong central tendency in the ruble-dollar ratios would provide strong, although not conclusive, evidence that the sample of projects is large enough to yield a ruble-dollar ratio close to that which would be obtained from a much larger sample.

#### A. Comparability of Projects

Soviet and US projects were judged to be sufficiently comparable if they were similar in respect to the following criteria (depending on the type of project): (1) use or function -- apartment housing, warehouse, blast furnace, road, and so on; (2) dimensions -- length, width, roof span, ceiling height, number of stories, and internal volume of the building; (3) type of construction of major structural components -- foundation, frame, exterior walls, roof support members, roof deck and roofing material, interior walls, and intermediate floors; and (4) utilities and conveniences -- central heating, electricity, hot and cold water plumbing, sewerage, ventilation, gas supply, fire protection, and elevators.

Projects built under unusual site conditions were rejected, except where adjustments to the cost of construction were feasible, as

in the use of foundation piles. Minor adjustments for other incomparabilities were made when necessary -- for example, removing the cost of air conditioning or adjusting for differences in ceiling height. Unquestionably, many incomparabilities remain between projects. Except for the important problem of quality of construction,\* however, these remaining differences are substantially less influential on the comparative cost of construction than are the criteria of comparability posed above and thus are not considered to be critical differences.

#### B. Representativeness of Projects

The representativeness of the projects compared is a question of the extent to which a given project (for example, housing) is typical or atypical of its kind in one or both countries. In the extreme instance, all or most of the projects in the sample might meet the test of comparability and yet be atypical of construction projects in one or both countries.

The question of representativeness is actually a weighting problem in that varying degrees of representativeness can be adjusted for by determining the relative importance of a project type in construction as a whole. Although intersectoral weights are available and are used in this report, information is not available for intra-sectoral weighting of housing projects, industrial projects, and so on. Where explicit weights are not available, the use of a simple averaging process entails implicit weighting. As a result, the methodology of the projects approach must include a criterion of representativeness.

Objective tests for meeting this criterion, however, are more elusive than those for comparability. Again, the size of the sample is an important question: the larger the sample of projects within sectors of construction, the less critical is the degree of representativeness of a given project. In this report, the samples of projects within sectors were small. Knowledge of common construction practices in the USSR and the US, therefore, was an important element in the acceptance or rejection of projects. Moreover, the basic sources used for data on Soviet and US projects were concerned with the costs of typical rather than atypical construction projects. Some otherwise acceptable projects were rejected because they were in one important way or another atypical of construction practices in the two countries. Beyond that, however, the range of variation in representativeness (relative importance) of the projects accepted is undoubtedly considerable.

#### C. Problem of Price Representativeness in Costs of Construction

In comparing the Soviet and US construction projects, cost of construction is defined as the agreed selling price at which a completed construction project is (or would be) turned over to the investor rather than the actual cost of construction for the construction

\* For a discussion of this question, see V, p. 20, below.

organization.\* For the US construction projects the agreed selling price is the accepted-bid price (or negotiated contract price) as reported in prices of the year in which construction was started, deflated to 1955 construction dollars where necessary.\*\* In the USSR the agreed selling price at which a Soviet project would be turned over to the investor is the estimate cost- (smetnaya stoimost') in adjusted 1955 prices: prices of construction materials, freight rates, and electric power rates as of 1 July 1955 and wage rates and overhead costs as of 1 January 1956.\*\*\* 1/†

The problem of regional variations in construction costs between the US and the USSR was dealt with on a geographic basis -- that is, in terms of climate and general topographic features that are roughly comparable in the two countries. For the Soviet construction projects, coefficients for adjusting the estimate costs are available for the various territorial zones and climatic regions. The location of a given project in the US was the determining factor for this adjustment: the geographic location in the USSR was chosen to approximate the geographic location in the US.†† For example, Karagandinskaya Oblast in Kazakhstan was used as the regional equivalent for construction in the area of Forbes Air Force Base in Kansas, Leningrad was matched with New York City, Kuybyshev with St. Louis, the Moldavian SSR with West Virginia, and so on.††† In the few cases where an average or composite cost was used for the US project, the costs of construction for the second territorial zone in the USSR were appropriate.

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\* The cost of producers' equipment that might be installed in a plant and the cost of installing that equipment are not included as cost of construction; similarly, the cost of land acquisition is not considered a cost of construction. The usual practice in construction in the USSR is to include the cost of installing producers' equipment; this is not the case for the costs of construction based on the Soviet handbooks for revaluing buildings and structures.

\*\* As far as is known, none of the US projects was built on a cost-plus basis. For a discussion of two exceptions to the pricing of projects that actually were built and for details on deflation to 1955 prices, see Appendix A. When appropriate indexes of construction costs are used, the errors introduced by the deflating procedures are not believed to be serious. Seven of the 25 US projects were reported in 1955 prices.

\*\*\* Two exceptions are discussed in Appendix A.

† For serially numbered source references, see Appendix C.

†† Construction under seismic codes was avoided in both countries. Although the USSR uses 10 territorial zones and 4 climatic regions in pricing construction, all of the Soviet geographic areas that were matched with the US locations were in zones 1 or 2 and climatic regions I, II, or III. In 1955, only a small share of construction in the USSR was being carried out in zones 3 through 10.

††† The range of regional variation in costs is exemplified by apartment construction: the variation in the cost indexes between the US regions represented in this report was about 17 percent, whereas the range in cost between zones 1 and 2 and climatic regions II and III in the USSR was about 10 percent.

The methodology for treating the regional variations in cost that result from the variance in supply and demand relationships between regions is more problematical. US projects were not included in the sample if booming or depressed construction markets were known to have or seemed to have unduly influenced the construction costs relative to average conditions in construction in the US. Regional variations in construction demand and supply also affect construction costs in the USSR, although on a more modest scale. The use of estimate costs rather than actual costs reduces such regional differences in costs.

Nearly all the US projects included in this report are real projects: a contract was awarded, and the project was built. The Soviet projects and costs, on the other hand, are nearly all synthetic in that sense. The Soviet handbooks for revaluing buildings and structures, the basic source used to obtain estimate costs for the Soviet projects, apparently contain average estimate costs of various types of construction projects of given physical specifications.\* Thus the revaluation handbooks do have the advantage of providing an estimate cost that probably is more representative of a given type of project than a single estimate cost that might be obtained for an individual project which was actually built.

Nevertheless, the question of price representativeness is more critical in the use of estimate costs for the Soviet projects than in the use of accepted-bid pricing for the US projects. The considerable degree of competition in construction in the US tends to keep actual costs and profits of different builders approximately in line with each other; the prevalence of competitive bidding thus tends to keep the contract or accepted-bid price of a US project approximately in line with the real opportunities for building it at that price. In the USSR, on the other hand, in the absence of competitive bidding and other competitive market forces, the range of variation in actual costs and profits of different construction organizations is exceptionally great. In this respect the use of estimate costs rather than actual costs for the Soviet projects eases the methodological problems to some degree, but questions of price representativeness remain.

In estimate costing in the USSR the cost for a given project is drawn up from input norms for the various components in construction -- materials, labor, overhead costs, and so on. The input norms, however -- and therefore the estimate cost -- are neutral or independent of the capabilities and the actual conditions of supply facing the Soviet construction organizations that will perform the work. Thus the question is posed -- is the estimate cost of a Soviet project approximately in line with the real opportunities for building it at such a price, or is it generally too low or too high to be representative of the real costs of construction in the USSR?

In addition to the absence of competitive bidding as a force for realism in the drawing up of estimate costs in the USSR, a number of considerations are involved in the situation as of 1955. Soviet

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\* The revaluation handbooks were compiled during 1958-59 by the State Committee of Construction Affairs, USSR, with the help of various construction institutes and other administrative organizations.

construction organizations faced considerably greater uncertainty in the supply of construction resources than building organizations in the US. Moreover, builders in the US operate with much stronger incentives to meet costs and make a profit than do Soviet building organizations. Although the Soviet construction industry as a whole finally turned a slight profit in 1955 (the first time in a number of years), a large proportion of individual construction organizations were still operating only with the help of state subsidies. A special variant of unrealistic costing is the frequent instance of escalation of the initial estimate costs of projects.\* These considerations indicate that the use of estimate costs for Soviet projects is still likely to understate the real costs at which Soviet projects are turned over to the investor compared with the use of contract or accepted-bid prices in the US. In general, however, the use of estimate costs from the revaluation handbooks is probably less important as a source of downward bias in the ruble-dollar ratios than other factors concerning the representativeness of the projects that are included in this report.\*\*

### III. Derivation of Ruble-Dollar Ratios for Construction Projects

#### A. Selection and Costing of Projects

The first step in the derivation of ruble-dollar ratios for construction projects in the USSR was to select the projects to be costed. Basic Soviet and US publications were scanned for engineering and economic data on different types of construction projects. 2/ During this process, any project that appeared to be atypical in design, in use of materials, or in construction techniques in the given country was excluded from further consideration under the test for representativeness. After a preliminary selection of projects of each country, a further search of data was made in an attempt to find comparable counterpart projects in the other country. Numerous projects had to be dropped because sufficient data on possible counterpart projects in the other country could not be found. Twenty-five pairs of projects finally were determined to have satisfied the requirements of comparability and representativeness.\*\*\*

The total cost of construction for each project was converted to a common unit cost basis -- for example, cost per cubic meter of internal volume in a given building. (The blast furnace projects, which were similar in design, were an exception -- an acceptable unit cost measure is not available for them.) The USSR and US unit costs for each pair of counterpart projects were compared to obtain a ruble-dollar ratio for each pair of projects. The ruble-dollar ratios thus derived are listed in Table 1.

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\* That is, estimate costs frequently are made on the low side: subsequent "improvements" of an estimate cost usually raise the cost without a commensurate increase in the designed capacity or service provided by the project. This operation strengthens the conviction that Soviet estimate costs understate real costs.

\*\* For a discussion of these factors, see V, p. 20, below.

\*\*\* For a description of these projects, see Table 5, Appendix A, p. 25, below.

Table 1

1955 Ruble-Dollar Ratios for Construction Projects  
in the USSR and the US a/

<u>Project Number</u>	<u>Type of Construction Project</u>	<u>Ruble-Dollar Ratio</u>
1	Apartment house	0.58
2	Apartment house	0.60
3	Apartment house project	0.69
4	Low-rent apartments	0.74
5	Private duplex house	0.75
6	Private single-family house	0.61
7	Parking garage	0.73
8	Building materials warehouse	0.55
9	Heated and ventilated warehouse	0.83
10	Grocery warehouse	0.88
11	Food-processing building	0.50
12	Warehouse and office	0.68
13	Office building	0.63
14	Plastic-casting plant	0.72
15	Maintenance shop	0.73
16	General warehouse	0.75
17	Steel mill building	0.80
18	Blast furnace	0.68
19	Airport runway (concrete)	1.02
20	Concrete highway (2-lane)	1.00
21	Small telephone exchange	0.59
22	Medium-size telephone exchange	0.67
23	Maintenance hangar	0.60
24	Industrial railroad spur	0.78
25	Mainline railroad	0.72

a. Project numbers refer to those in Table 5, Appendix A, p. 25, below.

B. Weighted and Unweighted Ruble-Dollar Ratios

The 1955 ruble-dollar ratio for construction, weighted by the Soviet mix in construction in 1955,\* was determined to be 0.70 ruble per dollar (see Table 2\*\*). The 1955 ruble-dollar ratio, weighted by the US mix in construction in 1955, was determined to be 0.71 ruble per dollar (see Table 3\*\*\*). Highway construction, which has one of the highest ruble-dollar ratios and which looms much larger in construction in the US than in the USSR, was weighted separately in the

\* For a description of the weights used for the USSR and the US, see Appendix A, 2, p. 23, below.

\*\* P. 12, below.

\*\*\* P. 13, below.

Table 2

## 1955 Ruble-Dollar Ratio for Construction, Using Soviet Weights

	(1)	(2)	(3)
<u>Soviet Sector of Construction a/</u>	<u>Soviet Sector Weights b/</u>	<u>Ruble-Dollar Ratio for Soviet Sectors of Construction c/</u>	<u>Soviet Sector-Weighted Factors d/</u>
Industry, Group A	0.360	0.72	0.259
Industry, Group B	0.044	0.69	0.030
Transportation and communications (including highways)	0.075	0.77	0.058
State and state- cooperative housing	0.218	0.65	0.142
Private housing	0.126	0.68	0.086
Trade, communal, and other	0.177	0.68	0.120
Total	<u>1.000</u>		<u>0.695 e/</u>
The 1955 ruble-dollar ratio, Soviet-weighted			0.70

a. 3/

b. For derivation of the Soviet sectoral weights, see Appendix A, 2, p. 23, below.

c. For derivation of the sectoral ruble-dollar ratios, see Table 8, Appendix A, p. 32, below.

d. Except for the total, Column (1) times Column (2).

e. The sum of the sector-weighted factors.

US mix. Were accurate weights available, separate weighting of construction of individual houses against apartment housing also would raise the US-weighted ruble-dollar ratio, but not significantly. On the other hand, adjustment for the lower quality of construction in the USSR, particularly in housing, definitely would raise the US-weighted ratio.\* Adjustments for the downward biases in the individual ruble-dollar ratios also would raise the Soviet-weighted ratio but less so than the US-weighted ratio because of the greater weight of housing construction in the US. Were such adjustments feasible, therefore, the spread between the Soviet-weighted ratio and the US-weighted ratio would be widened.

For those international comparisons in which, for the sake of simplicity, international differences in the sectoral structure of

\* For a discussion of separate weighting of housing in the US mix, see Appendix A, 2, p. 23, below, and for a discussion of the downward biases in the ruble-dollar ratios, see V, p. 20, below.

Table 3

## 1955 Ruble-Dollar Ratio for Construction, Using US Weights

	(1)	(2)	(3)
US Sector of Construction <u>a/</u>	US Sector Weights <u>b/</u>	Ruble-Dollar Ratio for US Sectors of Construction <u>c/</u>	US Sector-Weighted Factors <u>d/</u>
Industry	0.212	0.71	0.151
Highways	0.093	1.00	0.093
Transportation and communications (except highways)	0.027	0.73	0.020
Housing	0.436	0.66	0.288
Commercial and all other	0.231	0.68	0.157
Total	<u>1.000 e/</u>		<u>0.709 f/</u>
The 1955 ruble-dollar ratio, US-weighted			0.71

a. Because data for reclassifying construction by types is available for the US but not for the USSR, the classification of sectors and the grouping of projects under them generally follows that used for the USSR.

b. The sector weights for the US correspond to the respective shares of new construction put-in-place in current values of 1955 and are based on data reported by the US Department of Commerce, 4/ to which have been added the value of expenditures on well drilling for crude petroleum and natural gas. 5/ To bring the coverage of construction in the US into approximate accord with the construction base used in the Soviet weights, the US data exclude farm construction, conservation and development, and construction of military facilities (although it is not certain whether the Soviet data on construction exclude or include military facilities).

c. For derivation of the sectoral ruble-dollar ratios, see Table 9, Appendix A, p. 33, below.

d. Except for the total, Column (1) times Column (2).

e. Because of rounding, components do not add to the total shown.

f. The sum of the sector-weighted factors.

construction are not at issue, the geometric mean of the Soviet-weighted and US-weighted ratios provides a single ratio of 0.70 ruble per dollar (rounded from 0.702) that is within plus or minus 1 percent of the weighted ratios. The simple geometric mean of the unweighted ruble-dollar ratios for the 25 pairs of Soviet and US projects is also

0.70 ruble per dollar, and the simple arithmetic mean is nearly the same at 0.71.\* The median ratio is 0.72 ruble per dollar (see Table 4).

Table 4

Derivation  
of Median and Arithmetic Mean  
1955 Ruble-Dollar Ratios for  
Construction Projects in the  
USSR and the US

Project Number <u>a/</u>	Ruble-Dollar Ratio
11	0.50
8	0.55
1	0.58
21	0.59
23	0.60
2	0.60
6	0.61
13	0.63
22	0.67
12	0.68
18	0.68
3	0.69
25	0.72
14	0.72
15	0.73
7	0.73
4	0.74
5	0.75
16	0.75
24	0.78
17	0.80
9	0.83
10	0.88
20	1.00
19	1.02
Median	0.72
Arithmetic mean	0.71

a. Project numbers refer to those in Table 5, Appendix A, p. 25, below.

\* The simple means, arithmetic and geometric, are those determined without imputing Soviet or US sectoral weights.

\*\* P. 2, above.

\*\*\* An International Comparison of National Products and the Purchasing Power of Currencies, Organization for European Economic Cooperation (OEEC), Paris, [1953], p. 192-195..

A reasonably strong central tendency in the frequency distribution of the unweighted ruble-dollar ratios is evident in the chart.\*\* Of the 25 ratios, there are 9 that fall at the extremities of their respective class intervals. Although a slight increase or decrease (of 0.01) in these 9 ratios would change the distribution, the effect of some of these changes would be compensated for by the others. On balance, therefore, the class intervals that were chosen fairly represent the distribution of the unweighted ratios.

#### IV. Other Measures of Construction Ruble-Dollar Ratios

Unquestionably there are considerable difficulties in obtaining sufficient data for the projects approach to a construction ruble-dollar ratio -- and troublesome methodological problems as well. Basically, three alternative approaches to measurement of construction ruble-dollar ratios have been developed as means of avoiding these difficulties: (1) an inputs comparison, (2) a components comparison, and (3) a service comparison. The alternative approaches themselves, however, present a number of methodological problems that are compounded by the unavailability of data to resolve these problems.

With respect to international construction ratios, Norman Kaplan's treatise on the methodology of these approaches 6/ moves substantially beyond the comparative measures of construction achieved in the pioneering OEEC study by M. Gilbert and I.B. Kravis.\*\*\* In the discussion

to follow, the inputs and components approaches, examined extensively in the Kaplan study, will be treated briefly along with the service comparison. Finally, the results of a recent Soviet study of construction ruble-dollar ratios will be discussed and compared with the results obtained by way of the projects approach made in this report.

#### A. Inputs Approach

At first sight the inputs approach, basically a comparison of inputs price relatives between the USSR and the US, has the appeal of being a simple alternative to the difficulties involved in using the projects approach. The construction inputs are easily identifiable and common to both countries, and data on their prices and their relative importance in Soviet and US construction generally are available. There are, however, serious problems in using an inputs approach to measure construction ruble-dollar ratios, resulting from the simple fact that construction inputs are not construction outputs.

A comparison of materials inputs prices obviously is not a sufficient measure of comparative costs of construction, because it ignores the comparative costs of labor, capital, and overhead. Labor costs can be added by comparing construction wages, but adjustments to the wage relatives are mandatory because of international differences in labor productivity in construction.\* In fact, as Kaplan observes, the usual adjustments for international differences in labor productivity are not sufficient either, because the differences in labor productivity may be attributable in part to differences in the availability and use of capital in Soviet and US construction. Moreover, international differences in the productivity (that is, efficiency) of use of materials in construction should not be ignored. By and large, the Soviet construction industry is considerably less efficient in the use of materials in construction than is the US construction industry.

In effect, then, the inputs approach ideally should compare total inputs productivity -- that is, the total construction inputs required per unit of construction output. Thus the inputs approach itself falters finally on the difficulty of defining and measuring the comparable unit of construction output between the USSR and the US.

Ruble-dollar price ratios have been calculated for a sample of 19 construction materials.\*\* The simple average ratio was determined to be 0.77 ruble per dollar; weighted by the Soviet mix of construction materials in construction, the ratio is 0.80 ruble per dollar. Because of insufficient data, labor and capital costs have not been added, nor have productivity adjustments been made. Thus the ruble-dollar ratio obtained from the inputs approach cannot be compared accurately with the ratio obtained from the projects approach.

\* Thus, if Soviet bricklayers produce more or less per man-hour than US bricklayers, then comparison of hourly wages of Soviet and US bricklayers will not reflect the real costs of bricklaying in the two countries.

\*\* See Appendix B, 1, p. 35, below.

## B. Components Approach

The heterogeneity of construction projects (which complicates the projects approach) and the weaknesses of the inputs approach have led to the development of some alternative methodologies. The components approach involves a direct comparison of the unit costs of various construction components in the two countries.\* Construction components should be relatively more homogeneous between the USSR and the US than are construction projects, and it can be argued that projects are heterogeneous largely because they can embody so many different combinations of the many components that are common to the two countries.\*\* The principle of the components approach to international comparison, therefore, is that construction output in the USSR and the US is better described as aggregates of components than as aggregates of either projects or inputs.

The greatest disadvantage of the components approach arises from the absence of data for weighting the components price relatives. The quantities or relative importance of the many construction components used in construction in the two countries are not known. If data were available for comparing Soviet and US prices for a number of important construction components, it is possible that the various components price ratios would show a strong central tendency. A strong central tendency in the distribution of the price ratios would make precise weighting unnecessary; rough approximations of the relative importance of the components in Soviet or US construction would then suffice.

A modest approach toward a components comparison is shown in Table 11.\*\*\* Although the sample is small, the wide dispersion of the price ratios for the seven components shown raises serious doubts about the probability of a strong central tendency in the price relatives for construction components at large. Along with the great differences in the relative importance of the various components as used in Soviet apartment housing, the dispersion shown by the price ratios indicates that precise weighting is a critical requirement of a components approach. Thus the simple average of the components price relatives yields a ruble-dollar ratio of 0.69, but when weighted by the Soviet use of components the ratio rises to 0.74 ruble per dollar.

Comparisons of these ratios with those obtained by the projects approach for the state housing category (in Table 8†) are tenuous. Because the seven construction components could be among the components used in all four of the state housing projects, it is of interest to compare the simple average of the components price ratios (0.69 ruble per dollar) with the simple average of the state housing projects (0.65).

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\* Construction components can be thought of as the building blocks of construction projects, and the costs can be compared in common physical units -- for example, per cubic meter of brick wall (of given thickness), per square meter of wood subflooring or finished flooring, per square meter of roofing of various types, and so on.

\*\* It is not necessary to argue that all components are common to the two countries.

\*\*\* Appendix B, p. 37, below.

† Appendix A, p. 32, below.

Although these ratios are reasonably close, the critical need for weighting would seem to call in question the comparison. The weighted average of the components price ratios, however, would seem to demand comparison chiefly with the price ratio for Project No. 4 (in Table 8), and the two happily coincide at 0.74 ruble per dollar. In view of the absence of US weights for the components and other considerations,\* this identity probably has little meaning in support of either the projects or the components approaches.

### C. Service Approach

The service comparison is a practical but gross answer to the problems that arise from the heterogeneity of the construction end products. In this approach, costs of construction of facilities necessary for production of a given product or service in the two countries are compared, and the common measure is the unit of service or goods produced. The service approach has some things in common with the projects approach, but the requirement of comparability in designs, specifications, and materials used must be relaxed. In doing so the service approach can have the advantage of providing an easier means of determining price relatives for complex industrial projects.

Two approaches can be used in a service comparison. For example, the costs of construction of cement plants producing a given type of cement clinker can be compared for the USSR and the US, per ton of productive capacity.\*\* A more aggregative method would be to obtain the construction costs of a number of cement plant projects in both countries (independent of the comparability of any individual projects between the two countries) and to compare the average Soviet and US costs per ton of productive capacity. The basic weakness of the service approach for industrial construction, however, is that production capacity depends very little on the various types of construction involved but very much on the capacity of the productive machinery and equipment installed in a project. Thus the Soviet-US price ratios, although easily derived, are not really construction price ratios.

The results from a service comparison of Soviet and US housing construction that were obtained by the Soviet study of ruble-dollar ratios in construction are discussed below.

### D. Soviet Study of Construction Ruble-Dollar Ratios

A recent Soviet publication provides some details of a Soviet study of ruble-dollar ratios in construction. 7/ When 1955 prices were used for the USSR and 1954 prices for the US and when the ratios were weighted by the mix of construction in the USSR in 1958, the

\* For example, the components comparison does not include overhead costs, and the direct comparison only with Project No. 4 as best fitting the components data for three-story, four-story, and five-story apartments may be unwarranted.

\*\* Varying degrees of comparability might be sought -- for example, an equal number of cement kilns and stacks, slurry tanks, storage silos, and so on.

over-all ratio obtained was 0.78 ruble per dollar.\* The Soviet study combined a service comparison in housing construction with a projects approach in industrial and other construction.

In the industrial sphere the Soviet study compared the ruble-dollar costs of buildings with similar structural characteristics in 19 pairs of projects. The cost of the buildings (per cubic meter of volume) in the USSR ranged from 5.0 rubles to 22.5 rubles (in 1955 prices) and in the US from \$8.20 to \$28.80 (in 1954 prices). It is estimated that the ruble-dollar ratios obtained by the Soviet study ranged from a low of 0.53 to a high of 0.94. The arithmetic mean of the 19 ratios is estimated at 0.73 ruble per dollar.\*\* In this report the mean ratio obtained for projects of a similar category, Group A Industry, was 0.72 in 1955 prices for both the US and the USSR (see Table 8\*\*\*), whereas the mean ratio obtained by the Soviet study would be 0.71 if converted to 1955 prices.†

In the sphere of "nonproductive" construction (housing, schools, hospitals, stores, restaurants, and so on), the Soviet study yielded a ruble-dollar ratio of 0.82. In housing construction, specifically, it was reported that the cost per square meter of floorspace in the USSR in 1958 was 104 rubles (in 1955 prices) compared with about \$116 in the US (in 1954 prices).†† This implies a ruble-dollar ratio of 0.90 for

\* The weights were based on the volume of construction-installation work in industry, agriculture, and transportation and communications and on the volume of construction (or investment) in housing and other "nonproductive" facilities such as schools, hospitals, and stores. Private housing construction apparently was not included in the Soviet study. Because of insufficient data on agricultural projects in the US, agricultural construction was not included in this report.

\*\* The Soviet study states that the costs for the Soviet projects were derived from the Soviet handbooks on costs of buildings and structures in the USSR (as in source 8/) and that the costs for the US projects, in 1951 dollars, were from data compiled by the US firm of Marshall and Stevens, engineering consultants. The costs of the individual projects and the ruble-dollar ratios for the 19 projects were cited only in 1955 rubles and 1951 dollars. Although the means by which the 1951 prices were converted to 1954 prices were not indicated, it was possible to reconstruct the 1955 ruble - 1951 dollar ratios as 1955 ruble - 1954 dollar ratios by using a deflator of 0.88. The deflator was derived by comparing both the lowest cost US project and the highest cost US project in their 1951 prices with the 1954 price range (indicated above).

\*\*\* Appendix A, p. 32, below.

† The ratio in 1955 rubles - 1954 dollars can be converted to 1955 prices by a deflator of 0.97, which reflects the increase in construction costs in the US as shown by the Boeckh index of costs of commercial and factory buildings, 1954-55.

†† The Soviet study reveals that the average cost in the USSR was derived as the quotient of the value of capital investment in construction of state housing (private housing was not included), and the total floorspace of such housing constructed in 1958. The average cost in the US was derived as the quotient of the total value of contract awards for residential buildings in 1958 and the total floorspace of the buildings, from data compiled by the F.W. Dodge Corporation (deflated to 1954 prices).

housing construction by way of a service comparison, in contrast to the ratios that were obtained by the projects approach in this report (0.65 for state housing and 0.68 for private housing, in 1955 prices).

There are a number of errors, however, in the methodology employed. The Soviet study failed to make adjustments for differences in methods of measuring floorspace in housing construction in the USSR and the US. The average cost of housing in the USSR was measured in terms of total (useful) floorspace, obshchaya (poleznaya) ploshchad'. The Soviet concept of total floorspace includes only that floorspace within the apartment or dwelling units and excludes communal hallways, staircases, landings, and the thickness of exterior walls. The data on floorspace of residential buildings in the US, on the other hand, are derived from perimetric dimensions of the buildings rather than interior dwelling space. An examination of several typical designs of Soviet apartment buildings indicates that floorspace measured under the Soviet concept of total floorspace amounts to approximately 75 percent to 80 percent of the space measured by the perimetric dimensions of the buildings.\* 9/

The Soviet methodology is faulty also in the failure to compare approximately the same type of housing in the USSR and the US. Statistics on contract awards for residential building in the US encompass construction of both single-family houses and apartment housing. The cost for Soviet housing, however, was calculated only for housing under the state category, in which construction of single-family houses is negligible. The average cost of construction of apartment housing is greater than that for single-family houses (per measure of area or volume) in both the USSR and the US. Exclusion of the cost of private housing in the USSR, therefore, imparts another upward bias to the ruble-dollar ratio obtained by the Soviet study.

A third weakness in the service comparison of housing as employed by the Soviet study is inherent in the Soviet data on investment. The data on the amount of housing construction in the USSR are in terms of the total floorspace completed and turned over for use in 1958. The data on capital investment in construction of housing in 1958, however, include investment in (1) housing projects started in a preceding year and finished in 1958, (2) housing projects started and completed in 1958, and (3) housing projects started in 1958 but not completed by the end of 1958. Clearly an average cost of construction computed as the quotient of the value of investment and the amount of housing space completed in 1958 need not necessarily be the true average cost of construction.\*\*

\* Given the acceptability of the service comparison otherwise, this relationship could be used to adjust the average cost of housing to a common measurement of floorspace. The ruble-dollar ratio for housing would then be about 0.70 instead of the 0.90 obtained by the Soviet study. As indicated above, however, there are additional errors in the Soviet use of a service comparison.

\*\* For example, an increase of 41 percent in investment in state housing in 1957 was accompanied by an increase of 30 percent in completions in 1957, whereas in 1958 a 17-percent increase in investment was accompanied by an increase of 21 percent in completions. 10/ Thus the amount of carryover or unfinished [footnote continued on p. 20]

In sum, therefore, the difference between the over-all ruble-dollar ratio for construction derived by the Soviet study (0.78 in 1955 rubles and 1954 dollars) and the ruble-dollar ratio derived in this report (0.70 in 1955 rubles and 1954 dollars) is explicable chiefly as a matter of faulty methodology in the Soviet comparison of the costs of housing construction.\* The choice of 1958 weights in the Soviet study rather than the 1955 weights used in this report, although acceptable as such, results in an additional exaggeration of the difference. This is because investment in construction of state housing in the USSR amounted to one-third of the volume of construction-installation work performed under the state category in 1958 compared with one-fourth in 1955.

## V. Evaluations

The unweighted ruble-dollar ratios for the 25 pairs of projects display a reasonably strong central tendency for so small a sample (see the chart\*\*). Undoubtedly the sample should be much larger, particularly in view of the absence of data for intrasectoral weighting of projects. Ideally the sample should have a large enough and comprehensive enough collection of projects to be representative of both the Soviet and the US pattern of construction. In practice, however, it was largely the availability of data on Soviet construction projects that controlled the size and representativeness of the sample.

In industrial construction the size of the sample of projects in this report is less in question than is the representativeness of the sample.\*\*\* It seems quite likely that the absence of the necessary comparative data on construction of complex industrial projects in the USSR (aluminum plants, chemical enterprises, oil refineries, electric power stations, and so on) results in derived ruble-dollar ratios that are less than the true ratios for industrial construction

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construction work, a volatile factor in Soviet construction, can yield an upward or downward bias in calculation of average costs, depending on the direction of change in construction of housing.

\* Thus, for example, the Soviet study refers to the average cost of housing in the US as being in terms of "living space" (zhilaya ploshchad'), which it is not. Living space as well as "total floor-space" has a definite meaning in Soviet statistics on housing: it refers to habitable space such as living and dining rooms and bedrooms but not to kitchens, bathrooms, closets, and so on. In state housing in the USSR, living space amounts to about 65 percent of total floorspace. Finally, in calculating comparative labor productivity in construction in 1958 with the help of the over-all ruble-dollar ratio of 0.78, the total value of construction in the US was not deflated from 1958 prices to 1954 prices.

\*\* P. 2, above.

\*\*\* This statement is supported by the results of the Soviet study of buildings of the productive type. A sample of 19 projects (more than twice as large as the sample of projects carried in this report under the category of Group A Industry) yielded an average ruble-dollar ratio that was nearly identical to that obtained for similar projects in this report.

in 1955. The cost ratios for such complex projects would average higher than the average ratio obtained for such relatively simple structures as warehouses and industrial shops. The low ratio obtained for the blast furnace project (relative to those for warehouses and industrial shops) is a result of the special and successful effort made toward efficient construction of blast furnaces in the USSR. This situation, however, was not (and is not yet) typical of the pricing and construction of complex industrial projects in the USSR. In terms of time alone the duration of construction of complex industrial projects was considerably longer in the USSR in 1955 than in the US, relative to the comparative time required for projects such as warehouses and industrial shops. Unfortunately the very complexity of such industrial projects also makes the problem of finding comparable counterpart projects an insurmountable one.\*

Although not measurable in degree, the generally lower quality of construction in the USSR relative to that in the US is quite evident in kind.\*\* In respect to both comparability of the projects and representativeness of the sample, the differences in the quality of construction between the two countries are not amenable to adjustment. As a result, the ruble-dollar ratios in this report are lower than those that would be obtained if it were possible to adjust fully for the lower quality of Soviet construction. The clearest case is in housing, both in construction of private single-family houses and duplexes (that is, individual houses) and in construction of apartment housing.\*\*\*

An attempt was made to obtain Soviet and US projects in individual houses that are as comparable in quality as possible, but on balance the quality of the two US projects is still greater than in the two Soviet projects. Although no direct evidence is available, it is also likely that the imputed value of labor is understated in private construction in the USSR. Second, the individual housing projects that are compared can hardly be considered to be as representative of individual housing constructed in the US as they are for the USSR. The range of individual housing constructed in the US is phenomenal relative to that built in the USSR in 1955. On the presumption that each country is most efficient in constructing that which is most representative within itself, it would seem to be a foregone conclusion that a

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\* In this respect the components or the inputs approaches would be better alternatives than the projects approach if sufficient data were available.

\*\* References to quality of construction encompass the quality of the various construction components as components and the over-all quality of the finished project and the facilities provided by it. Greater quality of construction can be obtained in the USSR in many instances with little or no increase in cost, simply by better control and management of construction operations. For example, the more careful application of form oil and the placement and vibration of concrete in the forms would improve the quality of finish of precast concrete components. Other, more important increases in quality can be achieved only at higher cost, such as the use of higher quality materials and equipment in flooring, roofing, siding, plumbing and heating, elevators, and so on.

\*\*\* The quality of construction in industry and transportation in the USSR generally also is lower than in the US but not as markedly so as in housing.

representative sampling of individual housing constructed in the US, compared with housing over the same range of quality in the USSR, would raise further the ruble-dollar ratio for individual housing.

In the apartment projects an attempt also was made to compare projects as nearly equal in quality as possible, but on balance the quality of construction in all four Soviet projects (Project Nos. 1 through 4 in Table 5\*) is lower than in the counterpart projects in the US. The ruble-dollar ratio for Project No. 4 is higher than those for Project Nos. 1 through 3 because the Soviet Project No. 4 is more nearly comparable in quality to its counterpart project in the US than are Project Nos. 1 through 3. In apartment housing, too, the sample of projects is more representative of the USSR than of the US. Thus the ruble-dollar ratios that were obtained for apartment housing also are lower than the true ratios that would be obtained given adjustments for the lower quality of construction in the USSR and given a more representative sampling of construction in the US.

All in all, there do not appear to be any important factors making for an upward bias in the ratios obtained in this report. It is believed, on the other hand, that the impossibility of including complex industrial projects imparts a downward bias to the ruble-dollar ratio for industrial construction. Even more important is the downward bias resulting from the lower quality of housing constructed in the USSR and from the inadequate representation of the range of high-quality housing constructed in the US. Although Soviet estimate costs generally understate the real costs of construction in the USSR, this probably is less important as a source of downward bias than the inadequate representation of construction in the US in respect to high-quality housing and complex industrial projects.

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\* Appendix A, p. 25, below. The term high quality for the Soviet Project Nos. 1 through 3 is in reference to a Soviet reporting category that distinguishes between costs for low and for high quality of finish in the USSR.

## APPENDIX A

DERIVATION OF DATA IN THE PROJECTS APPROACH1. Comparison of Construction Costs of Soviet and US Projects

Brief descriptions of the 25 pairs of construction projects that were selected for comparison, together with the unit cost of each project, are given in Table 5.\* Costs for the US projects are accepted-bid prices for projects that were actually built, as reported in the year that construction was started; the two exceptions to this are US Project Nos. 18 and 25, which incorporate engineering estimates of the probable contract prices for building the projects. Costs of three projects, Nos. 3, 20, and 23, are composites of accepted-bid prices for a number of projects actually built. The costs of US Project Nos. 19 and 24 were deflated to 1955 prices by the Nebraska Highway Department Cost Index and the ICC Railroad Cost Index, respectively. All other US costs were adjusted to 1955 prices as necessary by an appropriate Boeckh index for various types of buildings in given geographic areas. 11/

Costs for the Soviet projects are in adjusted 1955 prices converted to new rubles. It is possible, however, that the adjusted 1955 prices for Soviet Project Nos. 5 and 6 incorporate overhead costs as reduced in 1958 rather than as of January 1956.

2. Sectoral Weights and Problems in Classification

Soviet sectoral weights for construction in 1955 correspond to the shares (in percent) of construction-installation work carried out in the respective sectors of construction in the USSR (excluding agriculture). The volume of construction-installation work by sector was estimated from the volume of capital investment by sector in 1955,\*\* adjusted by the various proportions of construction-installation work in investments in the given sectors (see Table 7\*\*\*). Such estimates were necessary because the USSR does not publish specific statistical series on the volume of construction-installation work performed in the various sectors of the economy.

In deriving sectoral ruble-dollar ratios for the USSR the projects were arrayed in accordance with Soviet classifications of major sectors of construction, 12/ as in Table 8.† A particular problem arises in respect to classification of the warehouses. Most projects of the warehouse type in this report may be freely substituted in use among the nonhousing sectors in the USSR, and there would be some construction of such buildings among each of these sectors. Project Nos. 10 and 11, however, are believed to be best classified under Group B Industry in respect to their association with the food industry (see Table 8).

\* P. 25, below.

\*\* Capital investment by sector in 1955 was derived as shown in Table 6, p. 30, below.

\*\*\* P. 31, below.

† P. 32, below.

Because these industries would absorb the greater part of warehouse construction in the USSR, all the remaining projects of the warehouse type were classified under Group A Industry.

In deriving sectoral ruble-dollar ratios for the US the projects were arrayed generally in accordance with classifications of construction that are used in the USSR (see Tables 3 and 9\*). All buildings of the warehouse type were classified as industrial warehouses, but Project No. 10, for example, could well be classified under commercial and all other in accordance with practices in the US. 13/

Because of the importance of highway construction in the US, the ruble-dollar ratio for highways was weighted separately from transportation and communications in the US.\*\* A separate weighting of highway construction in the USSR is not feasible, however, as the data are insufficient. Specific weights are not available for separation of individual houses from apartment housing in the US mix in construction. Even if the share of individual house construction were as much as 80 percent of all housing construction in the US in 1955 (in terms of value), however, the US-weighted over-all ruble-dollar ratio would be increased less than 1 percent by separate weighting.

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\* Pp. 13, above, and 33, below, respectively.

\*\* With highway construction weighted separately, the US-weighted over-all ruble-dollar ratio is 3 percent greater than it would be with highway construction included in a single weighting for transportation and communications.

Table 5

Derivation of 1955 Ruble-Dollar Ratios for Individual Construction Projects  
in the USSR and the US

Project Number	Description of US Project	Unit Cost (1955 US \$)	Description of Soviet Project	Unit Cost a/* (New Rubles)	Ruble-Dollar Ratio
1	<u>Apartment, New York City 14/</u> 14 stories, volume 77,810 cubic meters (cu m). Concrete frame and brick. Built in 1960, \$49.41 per cu m.  Adjusted cost (per cubic meter)	39.78	<u>Apartment, Leningrad 15/</u> 12 stories, volume to 200,000 cu m. Concrete frame and brick. High quality.  Cost (per cubic meter)	23.0	0.58
2	<u>Apartment, Little Rock, Arkansas 16/</u> 9 stories, volume 27,000 cu m. Concrete frame and walls (air conditioning removed from cost for comparison). Built in 1958, \$44.80 per cu m.  Adjusted cost (per cubic meter)	39.60	<u>Apartment, Krasnodar 17/</u> 9 stories, volume to 60,000 cu m. Concrete and faced brick. High quality. Cost adjusted to increase size of apartment units.  Cost (per cubic meter)	23.7	0.60
3	<u>Apartment project, New York City 18/</u> Six projects of varying heights, volume 1,015,530 cu m. Generally 4-room apartments with elevators (cost of unusual pile foundations deleted). Built in 1959, \$40.44 per cu m.  Adjusted cost (per cubic meter)	33.00	<u>Apartments, Leningrad 19/</u> 7 stories, volume to 25,000 cu m per building. Concrete and brick. All facilities, including elevators, of high quality. Cost adjusted for height of ceilings and apartment size.  Cost (per cubic meter)	22.8	0.69
4	<u>Apartments, Washington, D.C. 20/</u> Low rent, 48 units in 4 adjacent 3-story buildings. Floor area 3,399 square meters (sq m). Brick and cinder block. Built in 1956, \$117 per sq m.  Adjusted cost (per square meter)	112.00	<u>Apartments, Cherepovets 21/</u> Workers' housing, 48 units in a single 3-section, 4-story building. Floor area 2,661 sq m. Brick and concrete. Built during 1955-56.  Cost (per square meter)	82.7	0.74

\* Footnote follows on p. 29.

Derivation of 1955 Ruble-Dollar Ratios for Individual Construction Projects  
in the USSR and the US  
(Continued)

Project Number	Description of US Project	Unit Cost (1955 US \$)	Description of Soviet Project	Unit Cost a/ (New Rubles)	Ruble-Dollar Ratio
5	<u>Duplex house, Indianapolis, Indiana 22/</u>  Single-story, masonry, low-cost, minority-group private housing. Built for rental use. \$7.00 per square foot (sq ft).  Cost (per cubic meter)	25.10	<u>Duplex house, Belorussia 23/</u>  Single-story, masonry, 2- to 3-room units with roughly comparable facilities (units smaller than US units per family).  Cost (per cubic meter)	18.8	0.75
6	<u>Single-family house, Fort Worth, Texas 24/</u>  Floor area 800 sq ft. Frame and masonry, semifinished. Total cost \$4,780 less \$500 for carport. Cost \$5.35 per sq ft.  Cost (per cubic meter)	23.03	<u>Single-family house, Belorussia 25/</u>  Volume 192.5 cu m of heated area. For rural areas. Frame and masonry construction, also probably semifinished. Cost 2,700 rubles.  Cost (per cubic meter)	14.0	0.61
7	<u>Garage, Chicago, Illinois 26/</u>  Four stories, partly open. Concrete and masonry. Built in 1954, \$13.06 per cu m.  Adjusted cost (per cubic meter)	13.48	<u>Garage, Leningrad 27/</u>  Four stories, concrete and masonry (designed for smaller cars but of the same total volume).  Cost (per cubic meter)	9.8	0.73
8	<u>Warehouse, Cleveland, Ohio 28/</u>  Volume 5,613 cu m. Brick, steel, and timber. Built in 1956, \$20.12 per cu m.  Adjusted cost (per cubic meter)	19.11	<u>Warehouse, Gor'kiy 29/</u>  Volume up to 5,000 cu m. Brick, concrete, and steel.  Cost (per cubic meter)	10.5	0.55
9	<u>Warehouse, Salt Lake City, Utah 30/</u>  Volume 3,400 cu m. Brick construction with heat, electricity, ventilation, and plumbing. Built in 1956, \$10.89 per cu m.  Adjusted cost (per cubic meter)	10.54	<u>Warehouse, Kirov 31/</u>  Volume 3,001 to 6,000 cu m. Brick construction, with heat, electricity, ventilation, and plumbing.  Cost (per cubic meter)	8.7	0.83

Table 5  
(Continued)

Project Number	Description of US Project	Unit Cost (1955 US \$)	Description of Soviet Project	Unit Cost a/ (New Rubles)	Ruble-Dollar Ratio
10	<u>Warehouse, Springfield, Missouri 32/</u> Volume 10,286 cu m. For groceries. Masonry and precast concrete. Built in 1959, \$11.20 per cu m.  Adjusted cost (per cubic meter)	9.41	<u>Warehouse, Kuybyshev 33/</u> Single-story, volume up to 15,000 cu m. For processed foods. Brick and reinforced concrete.  Cost (per cubic meter)	8.3	0.88
11	<u>Food-processing building, Central, California 34/</u> Single-story, volume 401,672 cu m (air conditioning deleted). Steel frame, concrete tilt-up walls. Built in 1955.  Cost (per cubic meter)	7.39	<u>Port warehousing, Odessa area 35/</u> Volume 50,000 to 100,000 cu m. Steel frame and roof, brick walls.  Cost (per cubic meter)	3.7	0.50
12	<u>Warehouse and office building, Fort Washington, Pennsylvania 36/</u> Warehouse, volume 6,517 cu m, and office, 680 cu m. Built in 1958, \$14.82 per cu m.  Adjusted cost (per cubic meter)	13.43	<u>Warehouse and office building, Moscow Oblast 37/</u> A composite building from Soviet designs to match the US equivalent.  Cost (per cubic meter)	9.2	0.68
13	<u>Office building, St. Louis, Missouri 38/</u> Volume 11,400 cu m. Concrete construction. Built in 1960, \$33.26 per cu m.  Adjusted cost (per cubic meter)	28.44	<u>Administrative (office) building, Kuybyshev 39/</u> Two stories, volume to 10,000 cu m. Concrete, high quality.  Cost (per cubic meter)	17.8	0.63
14	<u>Plastics-casting and assembly plant, Glendale, West Virginia 40/</u> Low-cost, steel frame and concrete block. Built in 1956, \$9.18 per cu m.  Adjusted cost (per cubic meter)	8.66	<u>Shop for the chemical industry, Moldavian SSSR 41/</u> Single-story, few interior partitions, height to 5 meters (m).  Cost (per cubic meter)	6.2	0.72

Table 5

Derivation of 1955 Ruble-Dollar Ratios for Individual Construction Projects  
in the USSR and the US  
(Continued)

Project Number	Description of US Project	Unit Cost (1955 US \$)	Description of Soviet Project	Unit Cost a/ (New Rubles)	Ruble-Dollar Ratio
15	<u>Maintenance shop, US Air Force 42/</u>  Standard structure, precast concrete, concrete blocks and roof deck, crane-ways, built-up roofing. (1955 cost and design data.)		<u>Shop, mechanical, USSR 43/</u>  Standard structure, precast concrete, concrete blocks and roof deck, crane-ways, built-up roofing.		
	Cost (per cubic meter)	10.10	Cost (per cubic meter)	7.4	0.73
16	<u>Warehouse, US Air Force 44/</u>  Volume above 22,500 cu m. Standard steel frame and concrete block, 18- to 20-m spans. (1955 cost and design data.)		<u>Warehouse, USSR 45/</u>  Volume 15,000 to 30,000 cu m. Standard concrete frame and brick, 18-m span.		
	Cost (per cubic meter)	7.06	Cost (per cubic meter)	5.3	0.75
17	<u>Steel mill building, Ashland, Kentucky 46/</u>  Single-story, 12-m clearance, volume 90,000 cu m. Steel frame and steel siding. Built in 1956, \$7.41 per cu m.		<u>Steel mill building, Kursk area 47/</u>  Single-story, 12- to 15-m clearance, volume to 100,000 cu m. Steel frame and brick walls. (Average of several types.)		
	Adjusted cost (per cubic meter)	6.89	Cost (per cubic meter)	5.5	0.80
18	<u>Blast furnace, Great Lakes area 48/</u>  Including all facilities necessary for a new furnace at an existing plant. Data and estimated cost in 1956, \$5.3 million		<u>Blast furnace No. 13, Dneprodzerzhinsk 49/</u>  Including all facilities necessary for a new furnace at an existing plant. Very similar in size and design to the US unit.		
	Adjusted cost	5 million	Cost	3.4 million	0.68
19	<u>Runway, Forbes Air Force Base (AFB) 50/</u>  3,660 m x 61 x 43 centimeters (cm). 1,615 m of drains 15 to 168 cm in diameter. Built in 1954, \$16.50 per sq m.		<u>Runway, Karaganda Oblast 51/</u>  Cost dependent on depth of surface. Calculated for runway identical to that at Forbes AFB.		
	Adjusted cost (per square meter)	17.13	Cost (per square meter)	17.5	1.02

Table 5  
(Continued)

Project Number	Description of US Project	Unit Cost (1955 US \$)	Description of Soviet Project	Unit Cost a/ (New Rubles)	Ruble-Dollar Ratio
20	<u>Highway</u> , US composite mile <u>52/</u>  2-lane, 18 to 20 cm thick, concrete.  Cost (per kilometer)	71,250	<u>Highway</u> , USSR, same specifications as US composite mile. <u>53/</u>  Cost (per kilometer)	71,200	1.0
21	<u>Telephone exchange</u> , Abernathy, Texas <u>54/</u>  Volume 514 cu m. Reinforced concrete and brick. Built in 1958, \$42.35 per cu m.  Adjusted cost (per cubic meter)	38.37	<u>Telephone exchange</u> , Karagandinskaya Oblast <u>55/</u>  Reinforced concrete and brick. Small (for 6,000 numbers).  Cost (per cubic meter)	22.7	0.59
22	<u>Telephone exchange</u> , Central, New Hampshire <u>56/</u>  Volume 8,427 cu m. Reinforced concrete, brick, and masonry block. Built in 1957, \$33.35 per cu m.  Adjusted cost (per cubic meter)	29.88	<u>Telephone exchange</u> , Kalinin Region <u>57/</u>  Reinforced concrete and brick. Cost adjusted to compensate for increased volume.  Cost (per cubic meter)	20.0	0.67
23	<u>Hangar</u> , US Army, standard <u>58/</u>  Volume 35,563 cu m. Steel frame construction, steel roof and siding. 1956 cost, \$15.43 per cu m.  Adjusted cost (per cubic meter)	13.56	<u>Hangar</u> , average conditions <u>59/</u>  Volume 30,000 to 40,000 cu m. Steel frame construction, steel roof and siding.  Cost (per cubic meter)	8.2	0.60
24	<u>Railroad</u> , Arkansas <u>60/</u>  Access line to mining area. Hilly terrain, 110-lb rail. Built in 1960, \$89,000 per kilometer.  Adjusted cost (per kilometer)	75,000	<u>Railroad</u> , hilly terrain <u>61/</u>  Access line to industrial area. R-50-type rail.  Cost (per kilometer)	58,600	0.78
25	<u>Mainline railroad</u> <u>62/</u>  For average terrain conditions in the US; heavy-weight construction. Unpublished estimate by Association of American Railroads for 1955.  Cost (per kilometer)	112,500	<u>Mainline railroad</u> <u>63/</u>  For average terrain conditions in the USSR; heavy-weight construction. Cost of housing and ancillary work deleted.  Cost (per kilometer)	81,130	0.72

a. New rubles expressed in 1955 prices.

Table 5  
Derivation of the Volume of Capital Investment  
by Sector of Construction in the USSR  
1955

Sector of Construction	Capital Investment in 1956 <u>a/</u> (Million New Rubles) <u>c/</u>	Index of Investment in 1955 <u>b/</u> (1956 = 100)	Capital Investment by Sector in 1955 (Million New Rubles)
Industry, Group A	8,313	88.5	7,357
Industry, Group B	1,115	80.0	892
Transportation and communications (including highways)	1,811	85.4	1,547
State and state- cooperative housing	2,950	82.6	2,437
Private housing	1,519 <u>d/</u>	89.3 <u>e/</u>	1,356
Trade, communal and other	2,816	79.4	2,236

a. Source 64/ unless otherwise indicated.

b. Source 65/ unless otherwise indicated.

c. New rubles expressed in 1955 prices.

d. 66/

e. 67/

Table 7

Derivation of Sector Weights for Construction in the USSR  
1955

Sector of Construction	Capital Investment by Sector in 1955 a/ (Million New Rubles)	Estimated Construction-Installation Work in 1955		Sector Weights c/
		Share of 1956 b/ (Percent)	Volume (Million New Rubles)	
Industry, Group A	7,357	52.5	3,862	0.360
Industry, Group B	892	52.5	468	0.044
Transportation and communications (including highways)	1,547	52.4 d/	810 e/	0.075
State and state- cooperative housing	2,437	96.0	2,340	0.218
Private housing	1,356	100.0	1,356	0.126
Trade, communal and other	2,236	85.0	1,901	0.177
	<u>15,825</u>		<u>10,737 f/</u>	<u>1.000</u>

a. From Table 6, p. 30, above. New rubles expressed in 1955 prices.

b. 68/

c. The proportion of each sector in the total volume of construction-installation work in 1955.

d. Calculated from the residual (see e, below)

e. The sum of the volumes of construction of the other five sectors subtracted from the total -- that is, 10,737 minus 9,927 equals 810.

f. The sum of state and noncentralized construction-installation work and private housing construction minus the productive category of construction-installation work performed in state agriculture. 69/

Table 8

1955 Ruble-Dollar Ratios for Construction Projects  
Classified by Sector of Construction in the USSR a/

<u>Sector Classification</u>	<u>Project Number <u>b/</u></u>	<u>Ruble-Dollar Ratio</u>
Industry, Group A	8	0.55
	9	0.83
	12	0.68
	14	0.72
	15	0.73
	16	0.75
	17	0.80
	18	0.68
	Average ratio	0.72
Industry, Group B	10	0.88
	11	0.50
	Average ratio	0.69
Transportation and communications (including highways)	19	1.02
	20	1.00
	21	0.59
	22	0.67
	23	0.60
	24	0.78
	25	0.72
	Average ratio	0.77
State and state- cooperative housing	1	0.58
	2	0.60
	3	0.69
	4	0.74
	Average ratio	0.65
Private housing	5	0.75
	6	0.61
	Average ratio	0.68
Trade, communal and other	7	0.73
	13	0.63
	Average ratio	0.68

a. In the absence of data for intrasectoral weighting, the simple arithmetic mean of the ratios is used as the representative ratio.

b. The project numbers refer to those used in Table 5, p. 25, above.

Table 9

1955 Ruble-Dollar Ratios for Construction Projects  
Classified by Sector of Construction in the US a/

<u>Sector Classification</u>	<u>Project Number <u>b/</u></u>	<u>Ruble-Dollar Ratio</u>
Industry	8	0.55
	9	0.83
	10	0.88
	11	0.50
	12	0.68
	14	0.72
	15	0.73
	16	0.75
	17	0.80
	18	0.68
	Average ratio	0.71
Highway <u>c/</u>	20	1.00
Transportation and communications (except highways)	19	1.02
	21	0.59
	22	0.67
	23	0.60
	24	0.78
	25	0.72
	Average ratio	0.73
Housing	1	0.58
	2	0.60
	3	0.69
	4	0.74
	5	0.75
	6	0.61
	Average ratio	0.66
Commercial and all other	7	0.73
	13	0.63
	Average ratio	0.68

a. In the absence of data for intrasectoral weighting, the simple arithmetic mean of the ratios is used as the representative ratio.

b. The project numbers refer to those in Table 5, p. 25, above.

c. The ruble-dollar ratio for highway construction was derived by comparing composite mileage costs rather than specific highway projects.

## APPENDIX B

EXAMPLES OF ALTERNATIVE APPROACHES1. Ruble-Dollar Ratio for Construction Materials

Ruble-dollar ratios were derived for 19 construction materials. The simple average ruble-dollar ratio for construction materials was determined to be 0.77. A Soviet materials-weighted ruble-dollar ratio, the materials ratios weighted by the relative share of each material in the value of construction materials used in construction in the USSR, was determined to be 0.80 (see Table 10\*). Because data are not available for weighting by the relative shares of construction materials used in construction in the US, a US materials-weighted ruble-dollar ratio was not obtained. A weighted ratio using production weights in the US would not be comparable to the Soviet-weighted ratio.

2. Ruble-Dollar Ratios by Comparison of Construction Components

Sufficient data exist to permit comparison of 7 construction components that account for 73 percent of the direct cost of a four-story apartment building in the USSR. These data make possible the calculation of ruble-dollar ratios for apartment construction by means of the components approach, although comparable data on some important components such as plumbing, wiring, heating, and finishing work are not available for inclusion (see Table 11\*\*).

Unfortunately the components costs and weights are not available for other types of construction in the USSR. Therefore, this approach cannot be used to calculate ruble-dollar ratios for construction in general.

\* P. 36, below. The Soviet weights were based on the value (in 1955 prices) of each material used per million rubles of construction-installation work in the USSR. 70/ Apparently, double counting was avoided by valuing the materials according to end use in construction -- that is, cement and reinforcing steel used in precasting concrete components were included in the value of the precast components and not in cement or reinforcing steel.

\*\* P. 37, below.

1955 Ruble-Dollar Ratios for Selected Construction Materials  
in the USSR

Construction Materials	Share of Materials in Total Value of All Construction Materials in Soviet Construction a/ (Percent)	Share of Materials in the Sample b/ (Percent)	Unweighted Ruble-Dollar Ratio c/ c/	Soviet Materials-Weighted Factors d/ d/
1. Metal articles (steel shapes, rails, pipe, and so on)	10.59	17.31	0.80	0.1385
2. Structural steel	3.43	5.61	1.14	0.0640
3. Reinforcing steel	1.40	2.29	0.88	0.0202
4. Sawn lumber	7.23	11.82	0.61	0.0721
5. Railroad ties	2.70	4.41	1.10	0.0485
6. Cement	1.57	2.57	0.54	0.0139
7. Asbestos-cement siding	0.45	0.74	0.23	0.0017
8. Soft roofing	0.56	0.92	0.44	0.0040
9. Window glass	0.54	0.88	0.52	0.0046
10. Petroleum bitumen	0.47	0.77	1.20	0.0092
11. Lime	0.43	0.70	0.53	0.0037
12. Construction brick	8.96	14.65	0.45	0.0659
13. Precast concrete components	10.18	16.64	1.15	0.1914
14. Concrete (ready-mix)	6.77	11.07	0.74	0.0819
15. Mortar (ready-mix)	3.18	5.20	0.58	0.0302
16. Quarry stone	1.14	1.86	0.98	0.0182
17. Crushed stone	0.64	1.05	1.30	0.0136
18. Gravel	0.62	1.01	1.30	0.0131
19. Sand	0.31	0.51	0.23	0.0012
Total	61.17	100.00		0.7959
Simple average ruble-dollar ratio for construction materials			0.77 e/	
Soviet materials-weighted ruble-dollar ratio for construction materials				0.80

a. The shares of materials were based on the average structure of construction in the USSR as a whole, apparently from studies of the actual input structure during 1956-58, "with some correction coefficients for the input of materials anticipated for the beginning of the Seven Year Plan" (that is, 1958-59). The total value of all construction materials is defined to exclude loading and unloading costs as well as the truck transport costs for "local" construction materials (see c, below). 71/

b. The relative importance of each material in the total value of the 19 materials in the sample indicates its weight for the Soviet materials-weighted ruble-dollar ratio. Because of rounding, components do not add to the total shown.

c. The Soviet prices used were average prices for the USSR. Soviet prices for materials Nos. 1-11, inclusive, were f.o.b. railroad station of destination. For the so-called "local" materials, Nos. 12-19, Soviet prices were f.o.b. warehouse of supplier. For the most part, US prices used were averages of 20 cities, f.o.b. city (soft roofing was an average of f.o.b. factory prices in carload lots). Price comparability was sought on the basis of known characteristics of Soviet and US materials. Differences in quality or grade, if indeterminable, were ignored. 72/

d. Except for the total, the factors are the ruble-dollar ratios weighted by the share of each material in the total of materials sampled; the total is the sum of the factor ratios.

e. This figure is the arithmetic mean of the unweighted ruble-dollar ratios for the 19 construction materials.

Table 11

1955 Ruble-Dollar Ratios for Construction Components  
in Apartment Housing in the USSR a/

Construction Components	Unweighted Ruble-Dollar Ratio	Share of Components in the Cost of Construction in the USSR <u>b/</u> (Percent)	Share of Components in the Sample <u>c/</u> (Percent)	Soviet Components-Weighted Factors <u>d/</u>
Foundation	0.89 <u>e/</u>	7.5	10.2	0.091
Walls (load-bearing)	0.94 <u>f/</u>	30.5	41.6	0.391
Floor slabs	0.53 <u>g/</u>	14.8	20.2	0.107
Roof	0.55 <u>h/</u>	3.0	4.1	0.023
Doors	0.30 <u>i/</u>	9.4	12.8	0.038
Windows	0.70 <u>j/</u>	4.3	5.9	0.041
Stoves (gas)	1.00 <u>k/</u>	3.8	5.2	0.052
Total		<u>73.3</u>	<u>100.0</u>	<u>0.743</u>
Simple average ruble-dollar ratio for construction components			0.69	
Soviet components-weighted ruble-dollar ratio for construction components			0.74	

a. Unit costs of the construction components in the USSR were established as costs to be used in a Soviet competition for the best standard designs for three-, four-, and five-story apartment housing construction (see b, below). In both the US and the USSR the components costs are direct costs only -- that is, overhead costs are excluded.

b. The shares are those given in an example of a design for a four-story apartment building that was submitted in the competition. 73/ Data are not available for determining the relative importance of these components in the US, so that a US-weighted ratio cannot be obtained.

c. The relative importance of each component in the sample of seven components indicates its weight for the Soviet components-weighted ruble-dollar ratio.

d. Except for the total, the factors are the ruble-dollar ratios weighted by the share of each component in the total of components sampled. The total is the sum of the factor ratios.

e. The ratio for foundation work (basement walls and footings) was calculated as follows:

Table 11

1955 Ruble-Dollar Ratios for Construction Components  
in Apartment Housing a/  
(Continued)

USSR

Labor expended for foundation construction per square meter of living space -- 0.63 man-days. 74/

Labor expended for foundation construction per cubic meter of concrete used in the foundation -- 3.154 man-days. 75/

Cost of foundation work per square meter of living space -- 8.5 rubles. 76/

Therefore, man-days per cubic meter of foundation work divided by man-days per square meter of living space equals square meters of living space per cubic meter of foundation work. The substitution of figures gives  $\frac{3.154}{0.63} = 5.0$  square meters (sq m) living space per cubic meter (cu m) of foundation work. Because foundation work costs 8.5 rubles per sq m of living space, we can substitute and find that: 5.0 sq m of living space per cu m of foundation work multiplied by 8.5 rubles per sq m of living space equals 42.50 rubles per cu m of foundation work (that is, basement walls and footings).

By examination of standard plans 77/ it has been determined that each running meter of a basement wall 8 feet (ft) high contains 1.64 cu m of concrete and that each running meter of footings contains 0.64 cu m of concrete. Thus each running meter of foundation work contains 2.28 cu m of concrete.

Therefore, 2.28 cu m x 42.50 rubles per cu m = 96.90 rubles per linear meter of foundation work.

US

The cost of concrete poured and vibrated, including forms, reinforcement, and stripping of forms (equivalent operations are done at the casting yard or plant in the USSR, but these costs are included in the installed cost of the precast concrete in the USSR) 78/:

In footings -- \$30.00 per cubic yard x 1.308 = \$39.24 per cu m.

In walls -- \$39.00 per cubic yard x 1.308 = \$51.01 per cu m.

Using Soviet designs to determine the appropriate volumes of each of the above types of concrete, an equivalent US cost can be determined as follows:

Footings -- 0.64 cu m per linear meter x \$39.24 per cu m =	\$25.11
Walls -- 1.64 cu m per linear meter x \$51.01 per cu m =	83.66
Cost per linear meter of foundation work	<u>\$108.77</u>

The estimated ruble-dollar ratio for foundation work:

$$\frac{96.90 \text{ rubles}}{\$108.77} = \underline{\underline{0.89 : 1}}$$

Table 11

1955 Ruble-Dollar Ratios for Construction Components  
in Apartment Housing a/  
(Continued)

f. The ratio for load-bearing walls (unfinished interior and exterior) was calculated as follows (derived for only one of several types of masonry walls; construction of the other types of masonry walls is so similar that the ratio obtained should be valid for the other types):

USSR

Walls were of precast concrete blocks, reinforced, 12 inches (in) thick. Cost was 10.1 rubles per sq m of wall area (including cost of plastering and painting). The cost of finishing was calculated to be 2.3 rubles per sq m of wall area and was derived by comparison of the costs of finished walls of different thicknesses. Thus cost of wall, unfinished, was 7.8 rubles per sq m. 79/

US

The cost of concrete block walls, reinforced, 12 in thick was calculated to be \$0.77 per square foot (sq ft) of wall area or \$8.29 per sq m. 80/

The estimated ruble-dollar ratio for interior and exterior walls:

$$\frac{7.8 \text{ rubles per sq m}}{\$8.29 \text{ per sq m}} = \underline{\underline{0.94 : 1}}$$

g. The ratio for floor slabs was calculated as follows:

USSR

Precast reinforced concrete floor slabs: 7.93 rubles per sq m. 81/

US

Lift-slab, reinforced concrete, everything in place. \$1.40 per sq ft, \$15.06 per sq m. 82/

The estimated ruble-dollar ratio for floor slabs:

$$\frac{7.93 \text{ rubles}}{\$15.06} = \underline{\underline{0.53 : 1}}$$

h. The ratio for roof and roof deck was calculated as follows:

USSR

Tar and felt roofing on precast reinforced concrete roof slabs (deck), moderately pitched roof: 4.30 rubles per sq m. 83/

Table 11

1955 Ruble-Dollar Ratios for Construction Components  
in Apartment Housing a/  
(Continued)

US

Tar and felt roofing (with fine gravel finish) on lightweight concrete roofing planks (deck) 84/:

Lightweight concrete roof planks (installed on a flat roof)	\$54.35 per 100 sq ft
Additional labor cost for pitched roof	2.96 per 100 sq ft
Tar, felt, and gravel (applied)	14.95 per 100 sq ft
Total cost	<u>\$72.26</u> per 100 sq ft

US cost: \$0.7226 per sq ft x 10.76 (sq ft per sq m) = \$7.78 per sq m.

The estimated ruble-dollar ratio for roof and roof deck:

$$\frac{4.30 \text{ rubles}}{\$7.78} = \underline{\underline{0.55 : 1}}$$

- i. The ratio for doors was calculated as follows:

USSR

Exterior doors, apartment house, probably metal, 36.6 rubles each. 85/

US

Exterior doors, apartment house, school, or hospital, hollow metal, 3 ft by 7 ft, \$120 each. 86/

The estimated ruble-dollar ratio for doors (installed):

$$\frac{36.6 \text{ rubles each}}{\$120 \text{ each}} = \underline{\underline{0.30 : 1}}$$

- j. The ratio for windows was calculated as follows:

USSR

Fabricated units, installed with completed finishing, 16.7 rubles per sq m. 87/

US

Double-hung units, wood 2 ft 8 in by 4 ft 8 in -- that is, 12.4 sq ft (1.15 sq m).

Cost completely installed, including frame, \$27.50. 88/

Table 11

1955 Ruble-Dollar Ratios for Construction Components  
in Apartment Housing a/  
(Continued)

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Cost per sq m,  $\frac{\$27.50 \text{ per window unit}}{1.15 \text{ sq m per window unit}} = \$23.91 \text{ per sq m.}$

The estimated ruble-dollar ratio for window units:

$$\frac{16.7 \text{ rubles per sq m}}{\$23.91 \text{ per sq m}} = \underline{\underline{0.70 : 1}}$$

k. The ratio for stoves (installed) was calculated as follows:

USSR

Four-burner gas stove with supply lines, installed, 89.9 rubles each. 89/

US

Four-burner gas stove, apartment size (in quantity for housing development), installed, \$90 each. 90/

The estimated ruble-dollar ratio for gas stoves, installed:

$$\frac{89.9 \text{ rubles each}}{\$90 \text{ each}} = \underline{\underline{1.00 : 1}}$$

## APPENDIX C

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